Section 6.3

Rate Law and Order

- There is a mathematical relationship between the rate of reaction and the factors affecting the reaction.
- This relationship must be determined experimentally.

- The **RATE LAW** for a reaction describes the relationship between rate (r) and the product of the initial concentrations of the reactants raised to some exponential values.

given: $a\,X + b\,Y \rightarrow$ products

$$r = k[X]^m[Y]^n$$

- The exponents m and n describe the relationship between rate and initial concentration and must be determined experimentally.

- The value of m and n may be a whole number, zero or a fraction and do not have to equal the coefficients from the balanced chemical equation (i.e. a and b).

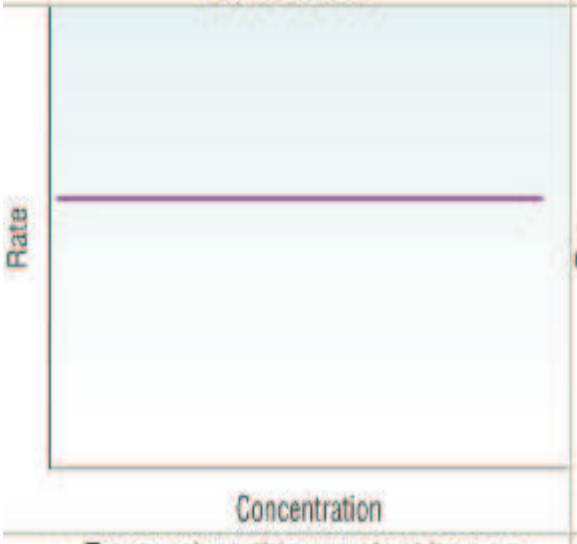
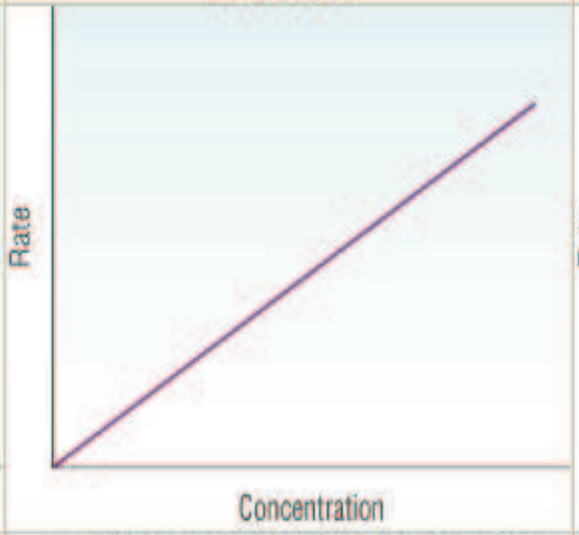
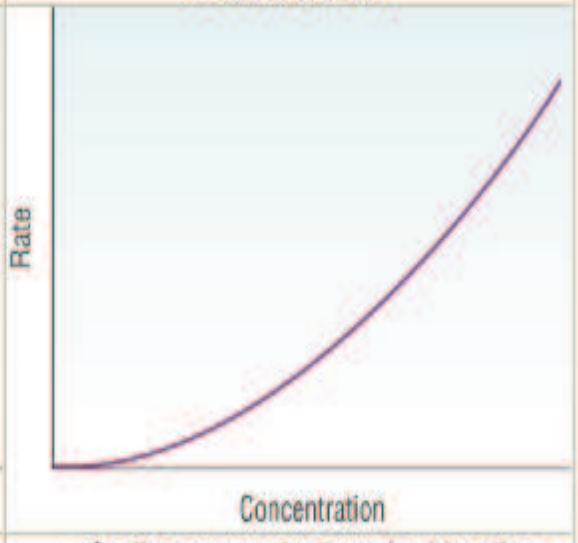
Relating Reaction Rate to Time

- The average rate of a reaction is inversely proportional to the time elapsed.

$$r_{av} \propto 1/\ \Delta t \ \text{ and } r_{av} \propto [A]^{m},$$

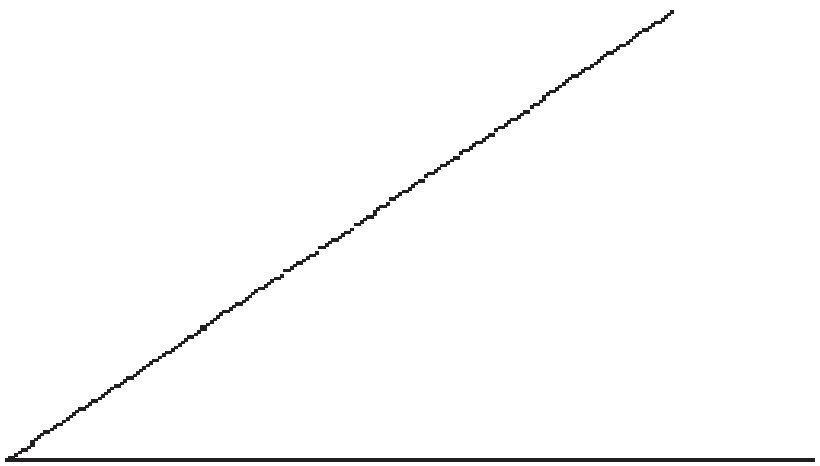
So we can graph 1/ t vs [A] to study what kind of relationship exists between rate and concentration of A

Orders of Reaction Displayed Graphically

Zero order	First order	Second order
		
• Remember, this reactant has no effect on the rate. • The rate continues at a steady pace.	• As the concentration doubles the rate also doubles, as the concentration triples, the rate triples. • The rate and concentration are in direct proportion to each other.	• As the concentration doubles the rate also quadruples, as the concentration triples, the rate increases by 9. • The rate increases by the square of the concentration. • What if rate - concentration^2 was plotted?
Horizontal straight line	**Proportional straight line**	**Proportional curve**

The graph shows that $R=k[A]^2$

Rate or $1/\Delta T$



Square of Concentration $[A]^2$

What does the slope of the graph represent in this situation?

The slope represents the rate constant k (think of y=mx + b, m is the slope)

For a particular reaction at constant temperature,

$A(g) + B(g) \rightarrow AB_{(g)}$

[A] (M)	[B] (M)	r (M/s)
1.00	1.00	1.00
2.00	1.00	2.00
3.00	1.00	3.00
4.00	1.00	?????

Determine the rate order in terms of A and the missing value.

Now, let's look at the other reactant
Determine the rate order in terms of B and the missing value.

[A] (M)	[B] (M)	r (M/s)
1.00	1.00	1.00
1.00	2.00	4.00
1.00	3.00	9.00
1.00	4.00	?????

The initial rate of the reaction:

$BrO^{3-}_{(aq)} + 5\ Br^{-}_{(aq)} + 8\ H^{+}_{(aq)} \longrightarrow 3\ Br_{2(l)} + H_2O_{(l)}$

Has been measured at the reactant concentrations shown:

$[BrO_3^-]$	$[Br^-]$	$[H^+]$	Initial rate (mol/Ls)
0.10	0.10	0.10	8.0×10^{-4}
0.20	0.10	0.10	1.6×10^{-3}
0.10	0.20	0.10	1.6×10^{-3}
0.10	0.10	0.20	3.2×10^{-3}

Determine the rate law.

Homework

Page 382 Activity 6.3

-Complete the graphs and answer the questions 1-4